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REPORT 9-1-1A2OFFICE, CHIEF OF ORDNANCE
June 1956

DEVELOPMENT

OF

STADIA RANGE FINDER, T45 (U)

*PREPARED FOR THE U. S. ARMY
MATERIEL COMMAND BY THE ARMY
MATERIEL RESEARCH STAFF,
UNIVERSITY OF PITTSBURGH,
UNDER CONTRACT DA-36-034-AMC-
3785(X)*.

Accuracy in range estimation plays so important a part in obtaining first-round hits in antitank fire that a number of new types of infantry range finder were put into development in the postwar period. Because of its small size, light weight, and simple design, the stadia type has been given particular consideration.

The idea of developing a stadia range finder for infantry use was suggested by a study made by APG of the range-finding mechanism of the USAF Type K3 caliber .50 automatic computing sight. An adaptation of this Air Force device was made and in November 1950 was sent to AFF Board No 3 for evaluation. The Board prepared a list of military characteristics for the item and in April 1951 Ordnance opened a subproject for the development of a stadia range finder, designated the T45, as part of a general project for the development of infantry range finders that had been active since 1946.

On receipt of authorization to develop the T45, Frankford Arsenal undertook the design, development and fabrication of two pilot models. In March 1955 the first pilot model was shipped to APG for engineering-testing, which is still under way. The second pilot model will be sent to CONARC Board No 3 for user tests when the engineering tests of the first pilot model have been completed.

The T45 stadia range finder can be used in conjunction with short-range infantry weapons to measure ranges to targets with one dimension within the spread from 4 to 30 feet. Such targets can be at any distance between 100 and 2,000 yards from the range finder. When using the instrument, either one dimension of the target must be known or it must be possible to estimate it quite accurately. An error in estimation of this dimension will result in a range error of the same proportion. Even though the measurements of a target are known, the dimension employed in the ranging operation must be estimated whenever the target is partially obscured or is presented at an

RELATED TIR'S

TIR 9-1

Development of Fire Control Instruments for
Infantry Weapons
Range Finder, T51

TIR 9-1-1A1

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angle to the range finders' axis. Errors in estimating dimensions can only be reduced by training and experience.

Restrictions on lens displacement make it impossible to employ all the combinations of target size and range shown on the dial scales. These combinations, however, represent extreme conditions of ranging that will probably not be met in combat.

The T45 stadia range finder is a hand-held monocular 6-power instrument which enables one man to find the range to a fixed or a moving target. The range problem is solved by using the relationship between similar triangles, as is illustrated below; in effect, the equation $R = W \cdot f/d$ is mechanized by the use of physical optics and mechanisms, as shown:



- d. Dimensions of inverted target image (known)
- f. Focal length O. Objective W. Target dimension (known) R. Range (unknown)

Two objective lenses, one stationary and the other movable, each form a separate image of the target on a common focal plane. Laterally shifting the movable objective until the two target images are aligned end-to-end moves one image through a distance that is proportional to the known length of the target. The amount of displacement of the movable objective when aligning the images is transmitted from a logarithmic cam concentric with a logarithmically-calibrated range dial on a common shaft. When the images are properly aligned, the lens displacement is translated into range, which can be read in yards on the range dial. A target-width dial concentric with the range dial and logarithmically calibrated with a scale showing units of target dimension in feet, enables the range to be changed proportionately whenever the target dimension changes.

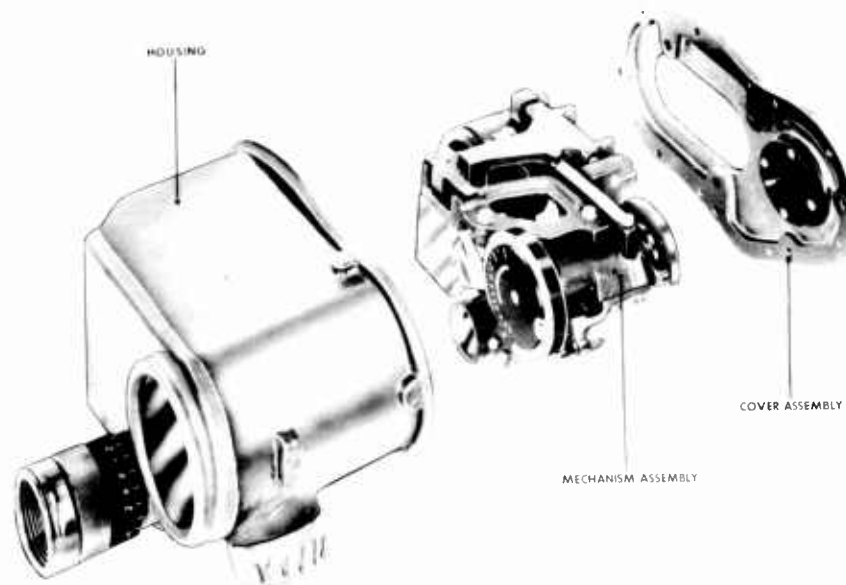
Ranges based on a known target height are as easily obtained as those based on width or length; it is only necessary to turn the instrument on its side and line up the target images vertically, top-to bottom, instead of end-to-end.

The T45 stadia range finder contains an optical and a mechanical system which, together, are designated the mechanism assembly. This assembly is fastened to a single base stand mounted as a unit on the front cover of a cast-aluminum housing. A target-width knob and a range knob protrude, respectively, from openings in the cover and in the side wall of the housing. A third opening contains the eyepiece.

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PARTLY-EXPLODED VIEW OF STADIA RANGE FINDER, T45

The optical system is made up of a protective front window; an eyepiece consisting of a singlet field lens and a doublet eye lens mounted in a common cell; a reticle; the stationary and movable objective lenses; and a prism cluster containing a rhomboid prism and two Porro prisms.

The eyepiece is a standard M13 binocular eyepiece with a plastic eye guard and a diopter scale graduated from +4 to -4 diopters in 1-diopter increments. A pattern etched on the reticle consists of a horizontal line which bisects the reticle and two vertical cross lines 10 mils apart. This pattern serves as a reference for adjusting the instrument.

Light rays from a target are brought to a focus in a common plane at the reticle by each of the two objective lenses. When the movable lens is displaced laterally by the ranging mechanism, it produces a variable azimuth deviation of the incident beam which can be interpreted in terms of range. The prism cluster combines the incident beams from the objectives and directs the combined beam to the reticle and eyepiece. It also acts as an erecting system so that the observer sees the images in a normal and erect manner.

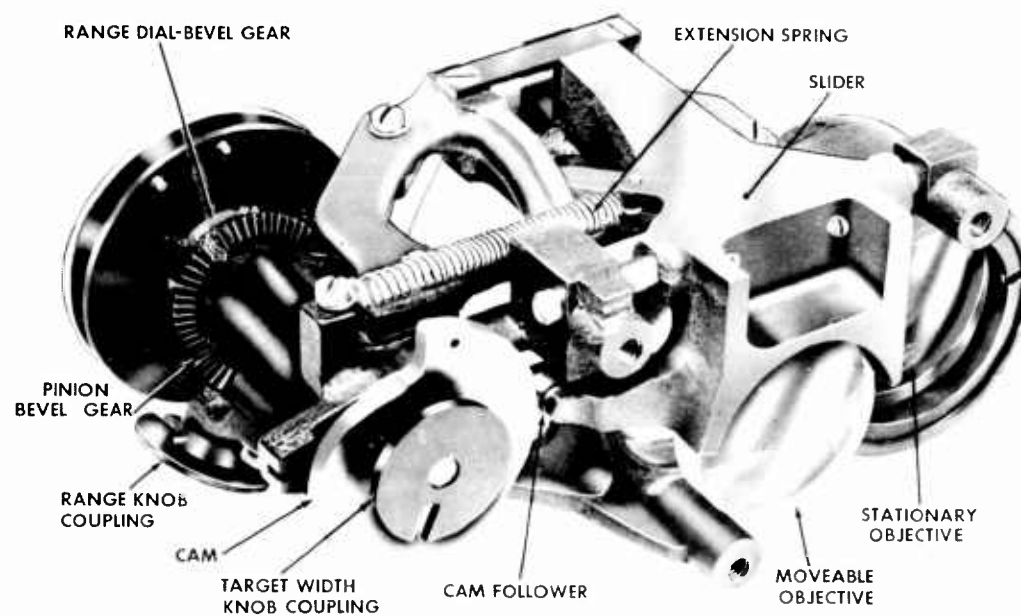
The ranging mechanism consists of a slider to which the movable objective lens is bonded, a range dial and a coaxial cam, a pinion

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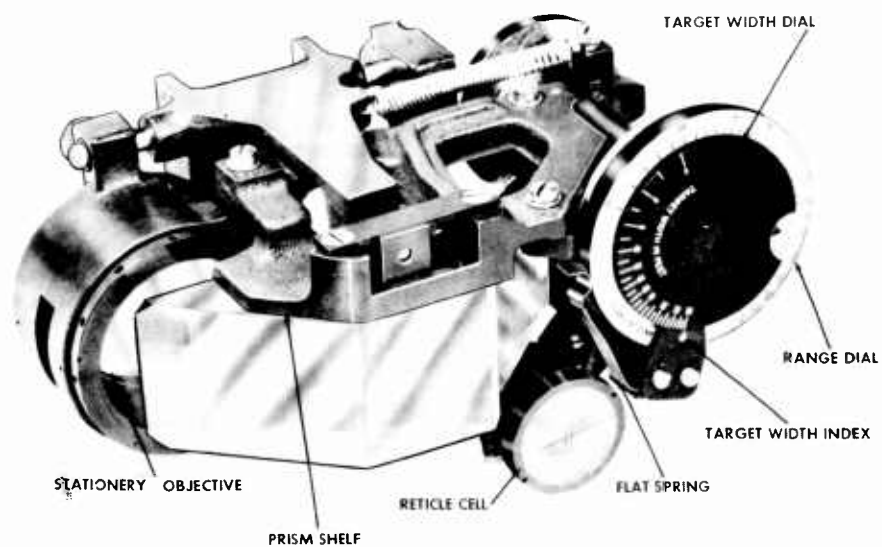
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STADIA RANGE FINDER, T45



RIGHT-FRONT VIEW OF MECHANISM ASSEMBLY
OF STADIA RANGE FINDER, T45



LEFT-REAR VIEW OF MECHANISM ASSEMBLY
OF STADIA RANGE FINDER, T45

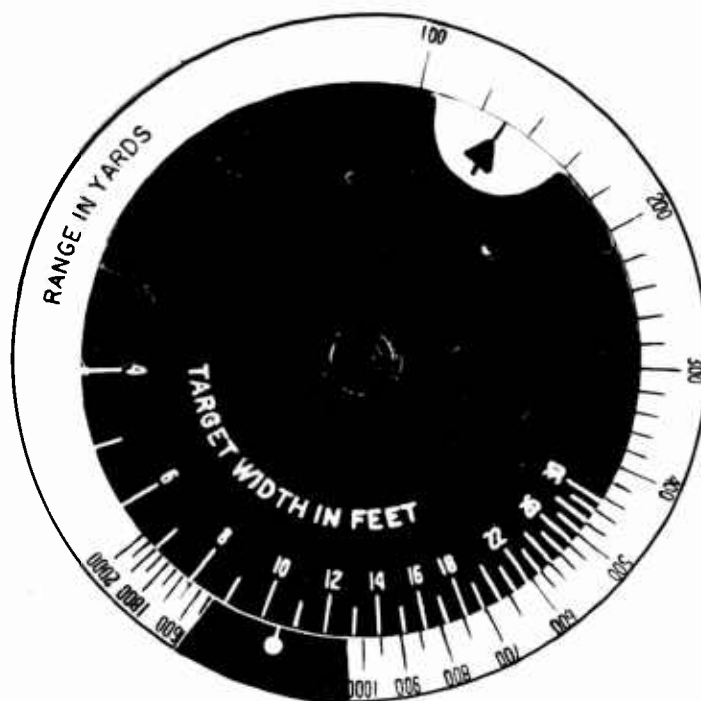
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RANGE AND TARGET WIDTH SCALES OF STADIA RANGE FINDER, T45

bevel gear, and a target-width dial and shaft. Rotation of the range knob introduces the lateral displacement of the movable objective into the range finder by imparting rotation, through the bevel gear, to the coaxial cam and range dial. Rotation of the cam laterally displaces the slider by an amount proportional to the range indexed on the range dial. Limitations in the slider and cam mechanism preclude the movable objective from reaching an infinity position, thus preventing the target image formed by the objective from ever completely coinciding with the image formed by the stationary objective.

The target-width scale, which has a fixed index, is logarithmically graduated from 4 to 30 feet in 1-foot increments, with numbers every 2 feet from 4 to 18 feet and every 4 feet from 18 to 30 feet. The index of the range scale, which is on the target-width scale, is graduated from 100 to 600 yards in 20-yard increments, and from 600 to 2,000 yards in 50-yard increments; these numbers are for each 100 yards between 100 and 1,000 yards and for each 200 yards between 1,000 and 2,000 yards. The index of the range scale is positioned by setting the target-width scale to the predetermined dimension of the target.

In operation, the range finder is held in the left hand and the right hand is used to turn the target-width and range knobs. The known target width is then indexed on the target-width dial. Next, while viewing the target through the eyepiece, the range knob is turned until the target images from the objectives are arranged side-

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by side and barely touching each other. When this is done, the range can be read from the range scale.

The development of the T45 stadia range finder has been completed.

TENTATIVE PRINCIPAL CHARACTERISTICS

T45 Range Finder

Weight	2.6 lb
Length	6 in
Width	6.5 in
Height	3.67 in
Field of view	8° 30'
Magnification	6X
Diameter of exit pupil	0.200 in
Clear-eye distance	0.184 in
Equivalent focal length of objective	5.191 in
Equivalent focal length of eyepiece	0.865 in
Diopter (one)	0.019 in
Diopter movement	4 to -4 diopters
Objective displacement	
Infinity position (nonexistent)	0.000 in
High-range position	0.0043 in
Adjustment position	0.0519 in
Low-range position	0.2596 in
Scale graduation	
Range	100 to 2,000 yd
Target width	4 to 30 ft
Scale increment	
Range	20 yd (100 to 600 yd); 50 yd (600 to 2,000 yd)
Target width	1 ft
Maximum range	2,000 yd
Allowable range error	2% at 1,000 yd
Temperature range	
Operating	-25° to 125° F
Storage	-80° to 160° F

T90 Carrying Case

Weight	1.4 lb
Length	7 in
Width	5 in
Height	7 in

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